

Opportunities and Challenges for China's Power Sector

John Byrne, Bo Shen and Jihong Zhao
Center for Energy and Environmental Policy
University of Delaware

May 1999

1. Current Energy Situation

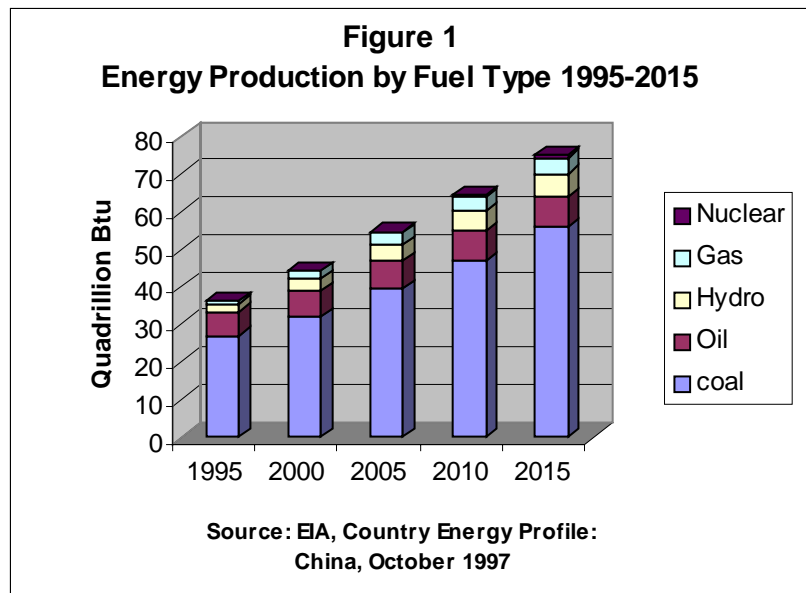
To fuel an annual GDP growth of 9% during the past two decades, China has dramatically increased its energy use and expanded its domestic production and imports of energy. Now, China ranks as the second largest energy consumer and producer in the world, following the U.S. By 1997, China's primary energy consumption reached 37.1 quadrillion Btu (quads), next only to 94.0 quads consumed in the United States (EIA, 1998).

At this time, China's energy sector is self-sufficient. Exports and imports of energy products are small compared to overall consumption, although the amount of imported oil and gas products and exported coal are expected to rise. China's self-sufficiency strategy has led it to depend heavily on coal for national energy needs. In 1996, coal accounted for 72.8 percent of total consumption, followed by oil with a share of 19.9 percent, and hydropower contributing 5.1 percent. Natural gas and nuclear power contributed only 2.1 percent and 0.4 percent respectively (Chandler et al, 1998).

The country's industrial sector is the main energy consumer, using about 60 percent of end-use energy. The transportation sector accounts for 12 percent of end-use energy. In contrast to most western countries, China's residential and commercial sectors consume only about 23 percent of end-use commercial energy, and the agricultural sector consumes only 5 percent, despite the fact that much of China's population continues to be involved in food and animal production (SETC, 1996). National economic reforms, which seek to restructure China's industry to higher added value enterprises, are expected to reduce the share of energy consumed by the industrial sector.

On the other hand, the shares of energy consumed by the transportation, residential and commercial sectors are expected to rise due to increasing incomes. Commercial energy consumption for agriculture is projected to be stable over the next decade.

2. *Projected Energy Sector Development*



The Chinese government has declared its intention to maintain high economic growth into the next century. To sustain this growth, the energy sector is planned for expansion. Figure 1 displays projections of China's energy production through 2015. Commercial energy supply is expected to reach about 44.3 quadrillion Btu (quads) in the year 2000, and 72.5 quads by 2015, an increase of almost 5 percent annually from 1995 to 2015 (EIA, 1997).

Coal is expected to retain its importance in China's energy production mix, with its share rising to 77.4 percent of the total by 2015. The hydropower share is expected to reach 6.2 percent, and natural gas is projected to grow to about 4.1 percent by 2015, as China begins to take greater advantage of its large domestic reserves. China has an ambitious plan to develop its nuclear energy, with the share from this risky technology officially expected to reach 1.6 percent by 2015. As domestic petroleum reserves shrink, petroleum's share will fall to 10.7 percent (EIA, 1997).

China's power sector has grown in step with the national economy. For the last ten years, about 10 GW of generation capacity was added annually. By 1998, the country was adding 15 GW per year. As a result, China's total generating capacity has reached 250 GW, with power generation amounting to 1,335 terawatt-hours in 1998 (*People's Daily*, Dec. 12, 1998). Per capita electricity consumption increased at an annual rate of about 9 percent over the past decade. Although rapid growth has been the hallmark of China's electricity program, per capita electricity use still remains low, roughly one third of the world average. Further, there are more than 60 million people, mainly in rural areas, who still do not have access to electricity (*Xinhua News Agency*, Dec. 8, 1998).

According to a recent international study (Chandler et al, 1998), China's power demand is expected to reach 1,390 terawatt-hours in 2000, 2,500 terawatt-hours in 2010, and 3,210 terawatt hours in 2015, respectively. Compared with earlier forecasts conducted by China's energy research organizations, this forecast considers recent changes in China's macroeconomic development, which build in higher electricity demand. While these projections are higher than official figures, it is likely that they more accurately portray the future, unless policy interventions to promote greater energy efficiency are taken.

3 Investment Required for Power Sector Expansion

In order to sufficiently meet the country's growing electricity demand, an addition of nearly 380 GW of capacity between 1999 and 2015 is needed. This expansion, however, requires a huge amount of investment. One report estimates that during 2000-2010, China's power sector will need almost \$315 billion to meet the capital requirements of its capacity expansion plans (Chandler et al, 1998). China assumes that 20 percent of its power sector capital requirement can be provided by foreign funds. This amounts to an annual flow of \$4.2 billion investment funds from foreign sources between 2000-2015. This would be an exceptionally high capital commitment, both in domestic and international terms, for an electricity sector's growth (see below).

4 The World Bank and Asian Development Bank's Participation in China's Structural Reforms and Energy Investments

China has been a member of the World Bank since 1981, and has been the Bank's largest borrower of investment financing since 1992. In FY98, World Bank Group (IBRD and IDA) lending to China totaled US\$2.62 billion (US\$2.32 billion in IBRD and US\$293.4 million in IDA), bringing cumulative lending as of June 30, 1998 to about US\$31.13 billion, of which US\$21.6 billion is IBRD and US\$9.53 billion is IDA. Among the US\$2.32 billion IBRD loans to China in FY 1998, about a quarter (US\$550 million) directly went to energy development (World Bank, 1999).

In the past few years, lending for environmental protection has become the fastest growing area of the World Bank's program in China. In FY98, four projects with lending totaling US\$350 million were approved, benefiting the urban environment, energy conservation, and coastal zone resources. The Bank's most recent assistance to Chinese policymakers is its environmental study, *Clear Water, Blue Skies*, produced in close collaboration with the China's State Environmental Protection Administration and the State Development Planning Commission. Other studies supported by the World Bank include: the environmental impact of coal use, greenhouse gas emissions control, and bio-diversity conservation. Based on the findings of these studies, the World Bank has earmarked US\$3.4 billion to improve air and water quality in China's cities. Furthermore, Bank-assisted power projects now routinely incorporate environmental standards in their design.

The Asian Development Bank (ADB) has played a similar role to that of the World Bank in China. The China's energy sector is also the principal recipient of ADB's loan support. Currently, six power projects are underway with ADB financing. These include two fossil fuel plants, two transmission projects, a wind farm and an environmental control project.

5. Issues That Will Arise or Have Arisen in the Energy Sector

As China's economy expands to meet the growing needs of its population, the country faces, and will continue to face, great challenges in balancing its goal of economic growth with energy, environmental and social sustainability. Several issues will need to be addressed in order for sustainable development to take place.

Financially, expanding energy supply and distribution systems at the planned rates by national authorities will place significant investment

burdens on the current and next generation. China's intention to increase power capacity by 380GW between 2000 and 2015 at a cost of more than \$300 billion is to be juxtaposed with the fact that available funding from multilateral organizations has been below \$1 billion per year in the 1990s. Further, there is the problem that well-developed domestic capital markets do not exist yet to finance energy projects of this magnitude. And foreign participation in China's energy projects will be hampered by the lack of a tested regulatory and legal framework that could address the risks associated with the foreign investment.

Along with sizable financial constraints, there are also major threats to environmental sustainability. Many of China's environmental problems stem from the increasing and inefficient use of fossil fuels, especially coal. For years, the people of China, particularly those living in cities, have breathed air with harmful levels of sulfur dioxide and particulates that are two to five times World Health Organization standards.

In addition, intensive and inefficient use of coal resources is creating one of the world's most serious acid problems. It is estimated that acid rain now affects nearly 40 percent of China's land area and causes over \$13 billion of damage annually to the country's forests, farms, and human health (Chandler et al, 1998). In producing approximately 14% of global CO₂ emissions, China is now recognized as the world's second largest emitter of greenhouse gases, trailing only the U.S. It is likely that China will soon become the world's leading source of CO₂ emissions if current trends of energy use continue.

China's power sector is also poorly coordinated within the government. Responsibilities for power-related energy development are widely dispersed among various agencies, making the development of a systematic and comprehensive energy strategy very difficult. If China is to meet its energy needs for sustainable development in the future, it needs to create a transparent organizational foundation.

In addition to the financial, environmental and institutional challenges facing China's power sector, the country is confronting great difficulties of providing reliable electricity service to its rural areas where three-quarters of the population live. Although the government of China has made significant efforts to bring electricity to its rural residents, 40% of the country's rural households (90% in the country's western provinces) still do not have access

to power grids because of the prohibitive costs of extending electricity services to remote rural areas.

Overall, these issues—investment gaps, environmental threats, institutional barriers and distribution problems—have surfaced to challenge China’s energy sector. Addressing these issues, however, cannot rely upon the fossil fuel-based, centralized options. Pursuing energy, social and environmental sustainability while continuing economic development in China requires increased use of alternatives such as energy efficiency and renewable energy.

6. *Trends and Directions of China’s Energy Sector*

While coal will continue to dominate the energy sector, China’s energy supply options will become diversified with increased exploration for and imports of oil and natural gas. Also, large-scale hydroelectricity and nuclear technology will be promoted by the government in order for the country to reach its electricity expansion goal.

In addition, China’s energy sector, especially the power sector, will continue its transition from a centrally-planned system to a market-oriented one. Reforming the country’s electricity tariffs, its foreign exchange system, the power project approval procedure and the regulatory framework will be accelerated as well. Currently, privatization is being discussed for power generation.

While these trends might reinforce the problems highlighted in the previous section, the emerging interest in developing renewable energy and energy efficiency options by the Chinese government offers more sustainable approach to energy issues. Energy efficiency and renewable energy options are emphasized in new development plans such as “China Agenda 21,” “Guidelines of the Ninth Five-Year Plan,” and the “Long Term Objectives for Economic and Social Development of China.” Regulatory and market-based incentive policies can be expected to encourage the development and deployment of energy efficiency and renewable energy.

The implications of these conflicting trends need to be recognized. Developing large-scale hydroelectric and nuclear projects is not only economically risky but also environmentally problematic. A study of China’s power sector released recently by the U.S. Pacific Northwest

National Laboratory indicates that the capital cost of building large-scale nuclear power or hydro electricity could be 45% higher than that of natural gas combined cycle units. The cost could be much higher if environmental and social impacts of developing large-scale nuclear and hydro programs are included (Chandler et al, 1998).

Energy efficiency and renewable energy could be the least-cost options for China to address its growing energy needs. The country has a great potential in improving energy efficiency and developing renewable energy options. Despite the impressive success in adopting efficiency measures, China still has one of the highest energy intensities in the world (the country on average requires three or four times as much energy input per unit of output as the developed countries) (*China's Agenda 21*, 1994). This fact indicates that China has great opportunities to improve its energy efficiency. In addition, China has abundant renewable energy resources. The country's geothermal reserves are equivalent to 3 billion tons of coal equivalent, but only 0.01% of this resource is being tapped. China's total wind power potential is estimated at 1,600GW. This is over eight times current Chinese electricity generation capacity. Similarly, the prospect for photovoltaic (PV) technology in China is strong. Most parts of China receive quite high levels of solar radiation, averaging 1,668 kWh per square meter annually. (*China's Agenda 21*, 1994) Developing China's abundant renewable energy resources would help the country to find a sustainable approach to addressing its growing energy needs, especially in rural areas.

Although China has made efforts in examining alternative energy options, it has focused its efforts primarily on efficiency improvement of its industrial sector from a supply perspective. In addition, its renewable energy efforts have concentrated on the development of large-scale, grid connected renewable energy technologies. Research conducted by the Center for Energy and Environmental Policy at the University of Delaware shows that China would gain more social, economic, energy and environmental benefits by implementing a full range of efficiency measures in its industrial, transportation, building, residential and commercial sectors and by increasingly developing decentralized, off-grid renewable energy technologies, especially in the country's rural areas (Byrne et al, 1996, 1998).

Reference

- Byrne, John, Bo Shen, and William Wallace. 1998. "The Economics of Sustainable Energy for Rural Development: A Study of Renewable Energy in Rural China" *Energy Policy* 26 (1): 45-54.
- Byrne, John, Bo Shen, and Xiuguo Li. 1996. "The Challenge of Sustainability: Balancing China's Energy, Economic and Environmental Goals" *Energy Policy* 24 (5): 455-462.
- Chandler, William, Zhou Dadi, Jeffrey Logan, Guo Yuan and Shi Yingyi, 1998, *China's Electric Power Options: An Analysis of Economic and Environmental Costs (Final Draft Prepared for the W. Alton Jones Foundation)*. Washington, DC: Pacific Northwest National Laboratory.
- China's Agenda 21: White Paper on China's Population, Environment, and Development in the 21st Century*, 1994, Beijing: China Environmental Science Press.
- Energy Information Administration (EIA), 1998, *International Energy Outlook 1998*, Washington, DC: U.S. Department of Energy.
- Energy Information Administration (EIA), 1997, *Country Energy Profile: China*, Washington, DC: U.S. Department of Energy.
- People's Daily* (overseas edition), 1998, 12th December, Beijing, China.
- State Economic and Trade Commission (SETC), 1996, *China Annual Energy Review*, Beijing, China.
- World Bank, 1999, *China and the World Bank*, Washington, DC: World Bank.
- Xinhua News Agency, 1998, "China's Stance on Global Climate Change", 8th December, Beijing, China.